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Productivity Enhancement of Wire Drawing through Root Cause Analysis (RCA)

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Abstract

Productivity enhancement has become an important goal for improving the production performance in many manufacturing industries. We have attempted to present productivity enhancement by improving the method of production and reducing the downtime of machine. Our main work highlights the maintenance and productivity improvement with the help of root cause analysis of wire drawing process in context with steel wires which are used in manufacturing of tires. So, here in this paper we provide knowledge of root cause analysis by using the why- why analysis tool to identify the origin of failure of machines for enhancing the productivity of steel wires. It provides a deep knowledge about the process, failure, methodology and overall details of wire drawing to improve the productivity and performance.

Keywords:-Productivity, Wire drawing, Root Cause Analysis, Why -Why approach.

INTRODUCTION

Productivity is the relationship between the outputs generated from a system to the input that are required to produce them. Productiveness is the measure on creation affectivity. Productivity is a standard measure of the viability of era. It can be imparted as the extent of respect incorporate utilized as a part of creation framework. I.E. Yield made per unit of data used. When all yield and data are solidified inside the productiveness measure it is called whole productiveness.

High productivity refers to doing the work in shortest possible time with least expenditure on inputs without sacrificing

quality and with minimum wastage of resources. (M Telsang-2010)

Mathematically it is expressed as:-

$$\textbf{productivity} = \frac{\textbf{output}}{\textbf{input}}$$

Productivity refers to the efficiency of the production system. It is the concept that guides the management of production system. It is an indicator of how well the factors of production (Land, Capital, labor and energy) are utilized.

European Productivity Agency (EPA) says that the productivity is an attitude of mind. It is the mentality of progress, of the constant improvements of that which exists. It is the certainty of being able to do better today than yesterday and continuously. It is the constant adaptation of economic and social life to changing conditions. It is the continual effort to apply new techniques and methods. It is the faith in human progress."

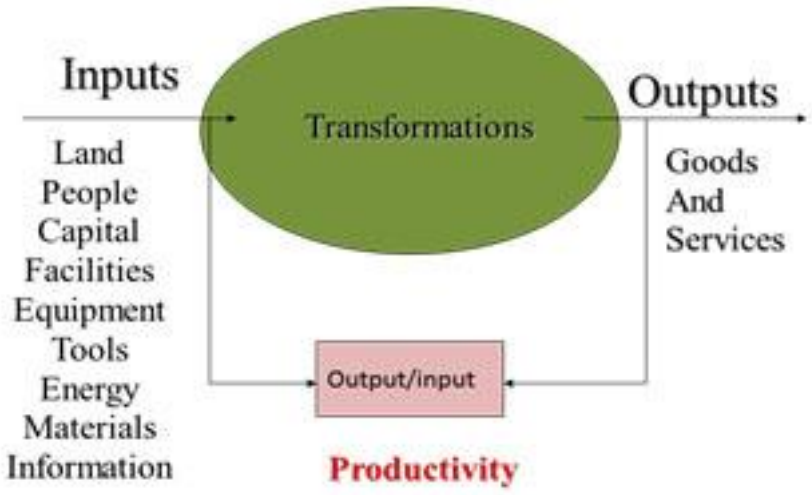

***Fig: 1** shows the system concept of production.*

Productivity is an average measure of the efficiency of production. It can be expressed as the ratio of output to inputs used in the production process. When all out put sand inputs are included in the productivity measure it is called total productivity. Outputs and inputs are defined in the total productivity measure as their economic values**.** [M.Telsang-1998].

LITERATURE REVIEW

Khalid et.al (2010) presents the work on the analysis of Motor Vehicle Periodic Inspection (MVPI) with the help of motion and time study techniques. The ARENA software is used in his work for simulation

and analysis. They represent the Mean inspection time and standard time for every inspection time with the help of graphical figures in their work.

Devi Prasad Mishra et.al (2013) focuses on improvement of productivity of coal mines. The work aims to identify the various problems affecting productivity in coal mine like side discharge loader (SDL) cable handling resulting in wastage of precious manpower resource and SDL breakdown.

T. Czumanski et.al (2012) highlights the work on applied analysis of labor productivity with the help of state-oriented approach. The work here is applied to identify the different impacts on labor productivity for subsequent process enhancements.

Tussatr in Wannagatesiri et.al (2015) conduct a quantitative survey on 357 local organization administrators views on training programs for the workers who are not working anywhere and do not have any skills. The programs conducted for the employment of these types of workers. Their short term training program was not effective as compare to long term program for providing employment. They mentioned the various graphs of percentage of labor attended different training program as vocational and non-vocational.

Arawati Agus et.al (2011) presents their work on Total Quality management technique (TQM) by analyzing the importance of method in the Malaysian manufacturing industry. The authors investigate the relationship between TQM, production performance and customer related performance. The work done here is based on the explaining the importance of TQM and increase performance of company.

Hamid Tohidi et.al (2011) actually provides a survey of research on teamwork productivity and effectiveness based on reward, leadership, training, goals, wage, size, motivation, measurement, and information technology.

SedatKarabay et.al (2008) represents the discussion and study of importance and application of predictive maintenance concept with the help of vibration measurements. The study based on the analysis of two manufacturing plants. Plant A is aerial conductor manufacturing plant and plant B shows detection of a ball bearing failure just in time. All the process

and analysis is done by considering the plant of wire and tyre manufacturing.

Adriana-Maria Mihu et.al (2016) presents the analysis with the help of 3D finite element simulation for the complex study of the drawing process with cassette roller die, of the round wires.

Mostafa et.al (2015) suggests that the waste elimination is very much important for reduction purpose. So here the paper based on the analysis of nine waste types and waste identification tool are revised. The proper study is based on waste documentations, waste analysis and waste removal. The paper mentions that the VSM method is considered as a common tool to visualize an activity flow.

PROBLEM FORMULATION

Gap analysis in wire drawing contains the information regarding the problems in wire drawing section, Table shown below it is clear that the downtime in the wire drawing section is much.

Downtime analysis in MT		
1	Electricity	55
2	Mechanical	72
3	Speed loss	297
4	Material shortage	117
5	Wire breakage	88
6	Die set	77

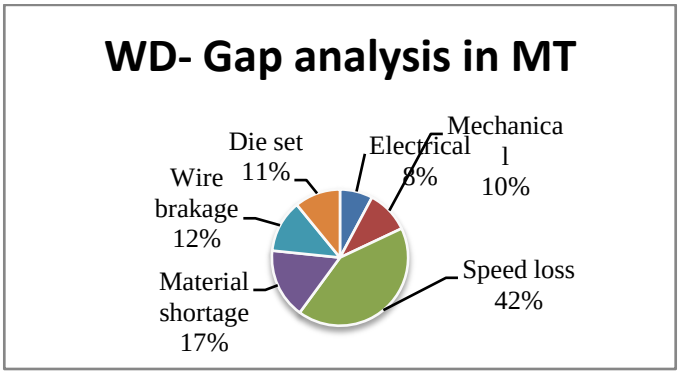

Table 1. Downtime in wire drawing ***Fig.2*** *shows the percentage of downtime foe different reasonsection due to different reason*

These are the problems observed in the wire drawing division.

- **Low efficiency:** there is the problem of low efficiency because of the high idle time or down time of machine and workers.
- **High down time**: there is very high down time of machines.
- **Under utilizations of available manpower**:In present method, production is less due to higher work content, in-effective utilization of time and non-valuable activities, which finally has effect on man power utilization. More operators are needed to achieve the production target within the available time. Thus the cost of

production increases, And it affect the customer demands.

- **Low production**:production is low in wire drawing division because of more down time of machine, old method of operation, and lack of proper utilization of workers.
- **Training:**Training is an important part to avoid the excess work content, variability and also rework but in present there is absence of facilities for casual training.
- **High wire breakage problem**: problem of the wire breakage is a big issue and the complaint of the customer is more and this is because of grade of wire use, variation in the draw force**,** speed of the motor.

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RESEARCH METHODOLOGY

Root cause analysis (RCA): RCA is a useful process for understanding and solving a problem. RCA is a systematic process for identifying "root causes" of problems or events and an approach for responding to them.

Wilson et al. (1993) have defined the Root Cause Analysis (RCA) as an analytic tool that can be used to perform a comprehensive, system-based review of critical incidents.

RCA has five steps

1. Define the problem:
   - What is happening?
   - What are the symptoms?
2. Collection of data:
   - What proof do you have that the problem exists?
   - What is the impact of the problem?
   - How long has the problem exist?
3. Identify possible casual factors
   - What is the sequence of events leads to the problem?
   - What is the condition which allow problem to occur?

During this stage, we identify as many casual factors as possible. Generally

people identify one or two factors and then stop, but that's not sufficient. With RCA you don't want to simply treat the most obvious causes, you want to dig deeper

4. Identify the root causes:

- Why does the casual factor exist?
- What is the actual reason that the problem occurred?

5. Recommend and implement the solution:

- What can you do to prevent the problem so that, it will not happen again?
- How will the solution be implemented?
- Who will be responsible for it?
- What are the risks to implement the solution?

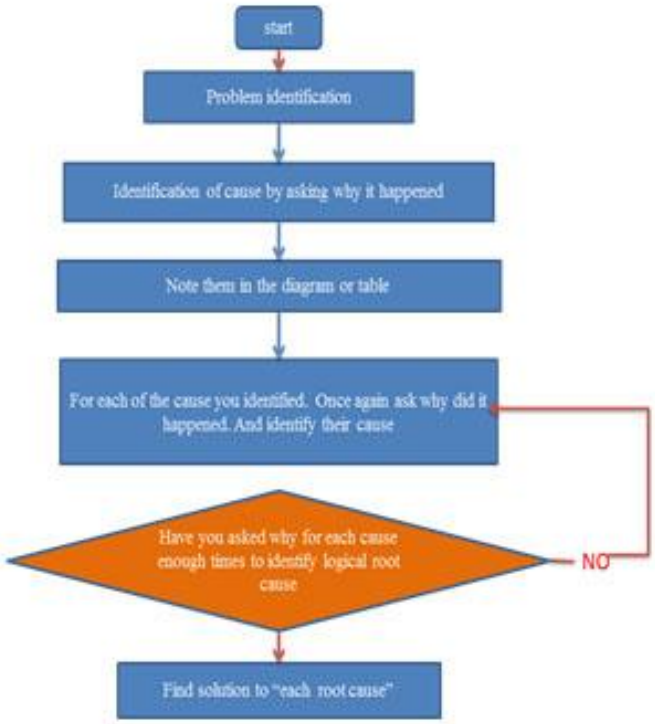

Fig. 3 *flow diagram of 5-why process*

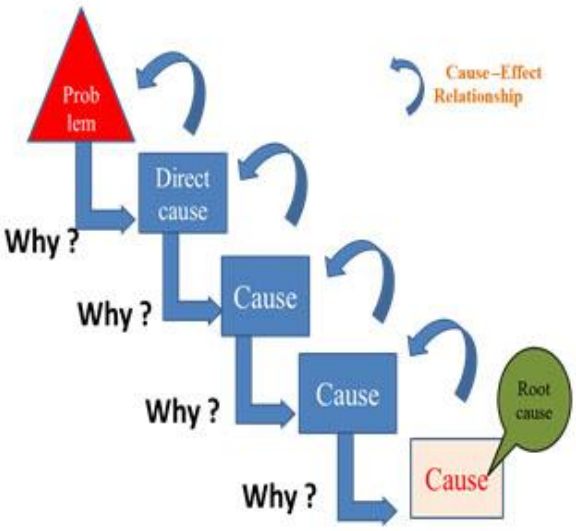

Fig. 4 *root cause analysis with the help of why-why approach*

Table. 2*Key points of different methods*

Method/Tool	**Type**	**Define Problem**	**Provide A Casual Path To Root Cause**
Event And Casual Factors	Method	Yes	No
Change Analysis	Tool	Yes	No
Barrier Analysis	Tool	Yes	No
Why-Why Analysis	Method	Yes	Yes
Pareto	Tool	Yes	No

Table. 2 introduced above discussed the main parameters of different methods from which we are able to compare and adopt the best working method for our analysis. The detailed discussion of our work and methodology was explained in the later sections.

DATA COLLECTION AND ANALYSIS

Rajratan global wire limited (RGWL) Company is the one of the leading company of India in the field of manufacturing. It manufactures the high carbon steel wire, specially the bead wire which is used for the manufacturing of tires which are used in automobile like car, truck, bus, motorcycle, and bicycles, and it manufactures some other useful products like spring and rope wires.

The site location of Rajratan global wire limited (RGWL) is in Pithampur- Dhar which is 30 Km ahead of Indore- Madhya

Pradesh India. Pithampur is a prominent industrial city in central India.

LINE WALK CHECK LIST FOR LINE OPERATOR

All the analysis done in this paper was performed with the help of plant manages engineers and supervisors. The whole work in this paper was performed on the basis of Why Why? Analysis and this analysis werebroadly classified with the help of Table. 3. The table represents the check list for line walk operator so, that he can prevent failure of machine.

Table. 3 *Line walk Check List for operator*

Line walk check list for Line Operator						
Section	**Wire Drawing**					
Location	**Sub-Component**	**Check points**	**riteria**	**Detection**	**Actual**	**Remarks if any**
Payoff -	Carry Plate & Pin	wear	No Wear	Inspection		
	Air Cylinder	Dust on the Cylinder	No Dust	Inspection-Cleaning		
		Air leakage	No air leakages	Inspection-Replace		
	Hand Lever Valve	Loose	No loose	Inspection-tightning		
	Break Assembly	Liner loose	Should be properly tighning	Inspection-tightning		
OTO Die Box Assembly	Die box entry roller	Jam/wear/Groove	No Jam/wear/Groove	Inspection - Cleaning/Replace		
	Die	Die position	Die should out from the die holder	Inspection - Correction		
	Die lock	Loose	No loose	Inspection-tightning		
	Die Holder	Water Leakage	No Water leakage	Inspection-Replace		
	Water Input / OutPut pipe	Chocking	It should not chocking	Inspection-Cleaning		
OTO Block	Over Head Pulley	Jam/missalignment	No Jam/missalignment	Inspection - Cleaning/Replac		

				e		
	OTO Liner	Loose	No loose	Inspection-tightning		
	OTO Liner Pulley	Jam/wear/Groove	No Jam/wear/Groove	Inspection - Cleaning/Replace		
	OTO drum.	Jam/wear/Groove	No Jam/wear/Groove	Inspection - Replace		
	Plumber Assembly	Noise	No noise	Inspection - Replace		
	Motor	Heating	No Heating	Inspection - Cleaning/Replace		
	Motor Pulley	Wear/grrove/Missalignment	No Wear/grrove/Missaligment	Inspection - Cleaning/Replace		
	Belt	Tightning	Should not loose	Inspection - Cleaning/Replace		
	Belt	No. of belt	As per standards	Inspection - Cleaning/Replace		
2nd to 5th Die Boxes	Die box entry roller	Wear/groove/missalignment	Should not Wear/groove/missaligment	Inspection - Cleaning/Replace		
	Die	Die position	Die should not out from the die holder	Inspection - Correction		
	Die lock	Loose	No loose	Inspection - Replace		
	Die Holder	Water Leakage	No Water leakage	Inspection - Replace		
	lubricant applicater's	Roller jam/groove/missallignment	No Roller jam/groove/missalligment	Inspection - Correction		
	Water Inupt / OutPut	Chocking	It should not chocking	Inspection - Correction		
	Dancer arm	Position	No loose /should be proper	Inspection - Tightning		

	Dancer arm roller	Jam/groove/missa lignment	No Jam/groove/missalig nment	Inspection - Replace		
	Dancer cylinder	Moovement	Should moovementproperly	Inspection - Correction		
	Dancer Sensor	Loose	No loose	Inspection - Tightning		
	Dancer Air Pressure	Pressure should not less or more	2 to 4 Kg	Inspection - Correction		
	Dancer air pipe	Dancer air pipe condition	No air leakages	Inspection, air pressure indicator		
2nd to 5th block	Drum Dia.	Groove/Jam	No groove/Jam	Inspection		
	Plumber Block assembly	Noise	No noise	Inspection- Cleaning		
	Motor	Heating/dust	No Heating	Inspection- Cleaning		
		Motor fan	No Jam/dust	Inspection- Cleaning		
	Drive	Dust	No dust	Inspection- Cleaning		
	Belt	Tightning	Should not loose	Inspection- tightning		
	Water Pressure Gauge	Water pressure	2 to 3 Kg	Inspection		
6th to 9 Die Boxes	Die box entry roller	Wear/groove/mis salignment	Should not Wear/groove/missali gnment	Inspection - Cleaning/Replac e		
	Die	Die position	Die should not out from the die holder	Inspection - Correction		
	Die lock	Loose	No loose	Inspection - Replace		
	Die Holder	Water Leakage	No Water leakage	Inspection - Replace		
	lubricant	Roller	No Roller	Inspection -		

	applicater's	jam/groove/missa llignment	jam/groove/missallig nment	Correction		
	Water Inupt / OutPut	Chocking	It should not chocking	Inspection - Correction		
	Dancer arm	Position	No loose /should be proper	Inspection - Tightning		
	Dancer arm roller	Jam/groove/missa lignment	No Jam/groove/missalig nment	Inspection - Replace		
	Dancer cylinder	Moovement	Should moovementproperly	Inspection - Correction		
	Dancer Sensor	Loose	No loose	Inspection - Tightning		
	Dancer Air Pressure	Pressure should not less or more	2 to 4 Kg	Inspection - Correction		
	Dancer air pipe	Dancer air pipe condition	No air leakages	Inspection, air pressure indicator		
6th to 9th block	Drum Dia.	Groove/Jam	No groove/Jam	Inspection		
	Plumber Block assembly	Noise	No noise	Inspection-Cleaning		
	Motor	Heating/dust	No Heating	Inspection-Cleaning		
		Motor fan	No Jam/dust	Inspection-Cleaning		
	Drive	Dust	No dust	Inspection-Cleaning		
	Belt	Tightning	Should not loose	Inspection-tightning		
	Water Pressure Gauge	Water pressure	2 to 3 Kg	Inspection		
10th to 14th Die Boxes	Die box entry roller	Wear/groove/mis salignment	Should not Wear/groove/missali gnment	Inspection - Cleaning/Replac e		
	Die	Die position	Die should not out	Inspection -		

			from the die holder	Correction		
	Die lock	Loose	No loose	Inspection - Replace		
	Die Holder	Water Leakage	No Water leakage	Inspection - Replace		
	lubricant applicater's	Roller jam/groove/missallignment	No Roller jam/groove/missallignment	Inspection - Correction		
	Water Inupt / OutPut	Chocking	It should not chocking	Inspection - Correction		
	Dancer arm	Position	No loose /should be proper	Inspection - Tightening		
	Dancer arm roller	Jam/groove/missalignment	No Jam/groove/missalignment	Inspection - Replace		
	Dancer cylinder	Moovement	Should moovementproperly	Inspection - Correction		
	Dancer Sensor	Loose	No loose	Inspection - Tightning		
	Dancer Air Pressure	Pressure should not less or more	2 to 4 Kg	Inspection - Correction		
	Dancer air pipe	Dancer air pipe condition	No air leakages	Inspection, air pressure indicator		
10th to 14th block	Drum Dia.	Groove/Jam	No groove/Jam	Inspection		
	Plumber Block assembly	Noise	No noise	Inspection-Cleaning		
	Motor	Heating/dust	No Heating	Inspection-Cleaning		
		Motor fan	No Jam/dust	Inspection-Cleaning		
	Drive	Dust	No dust	Inspection-Cleaning		
	Belt	Tightning	Should not loose	Inspection-tightning		
	Water	Water pressure	2 to 3 Kg	Inspection		

	Pressure Gauge					
Killing Roller	Bearing	Groove/jam/miss alignment	No Groove/jam/missalignment	Inspection - Cleaning/Replace		
	Circular Pulley	Groove/jam/miss alignment	No Groove/jam/missalignment	Inspection - Cleaning/Replace		
Dancer Unit	Dancer Pulley	Groove/jam/miss alignment	No Groove/jam/missalignment	Inspection - Cleaning/Replace		
	Dancer Air Cylinder	Moovement	Should moovementproperly	Inspection - Correction		
	Pedestel Bearing	Groove/jam/miss alignment	No Groove/jam/missalignment	Inspection - Cleaning/Replace		
Spooler Unit	Traverse Guide Pulley	Groove/jam/miss alignment	No Groove/jam/missalignment	Inspection - Cleaning/Replace		
	Traverse Motor	Heating/dust	No Heating/dust	Inspection - Cleaning		
	Drive Side Unit	Heating/dust	No Heating/dust	Inspection - Cleaning		
	Carry plate & pin	wear	No Wear	Inspection		
	Non Drive Side Unit	Heating/dust	No Heating/dust	Inspection - Cleaning		
	Pintle assembly	Heating/dust	No Heating/dust	Inspection - Cleaning		
	Motor	Heating/dust	No Heating/dust	Inspection - Cleaning		
	Belt	Tightning	Should not loose	Inspection-tightning		
	Bobbin	Wobbling	NO Wobbling	Inspection-Replace		
	Bobbin	Bobbin filling	No taper/loose	Inspection-Correction		

RESULT AND DISCUSSION

BENEFITS OF THE PROJECT

1. **Reduction in the number of RCA performed:** the number of RCA performed is much reduced and it shows that the failure of machine is less before the implementation.

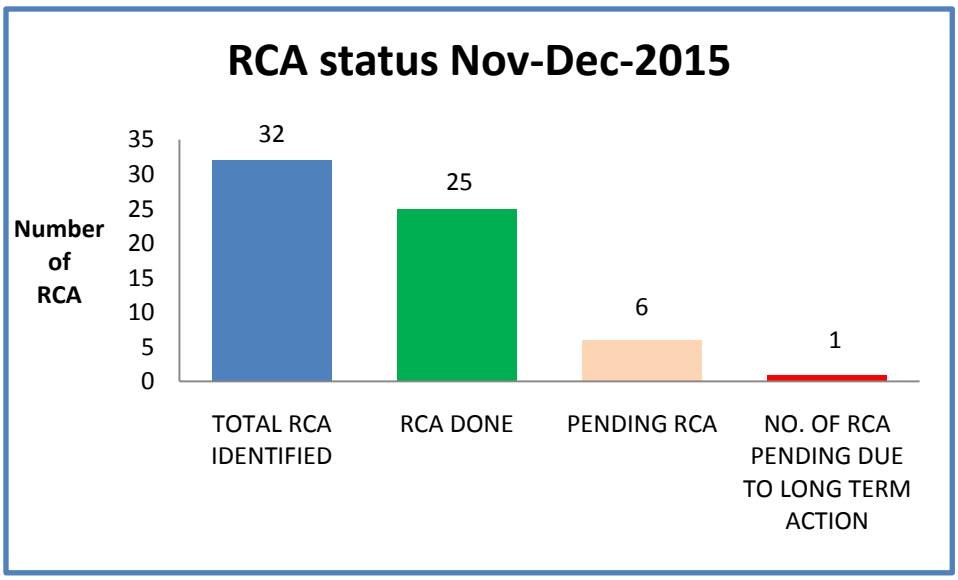

Fig. 5 *shows the RCA analysis*

2. **Increase in the production trend**: - production of the wire drawing increases in December with the help of root cause analysis.

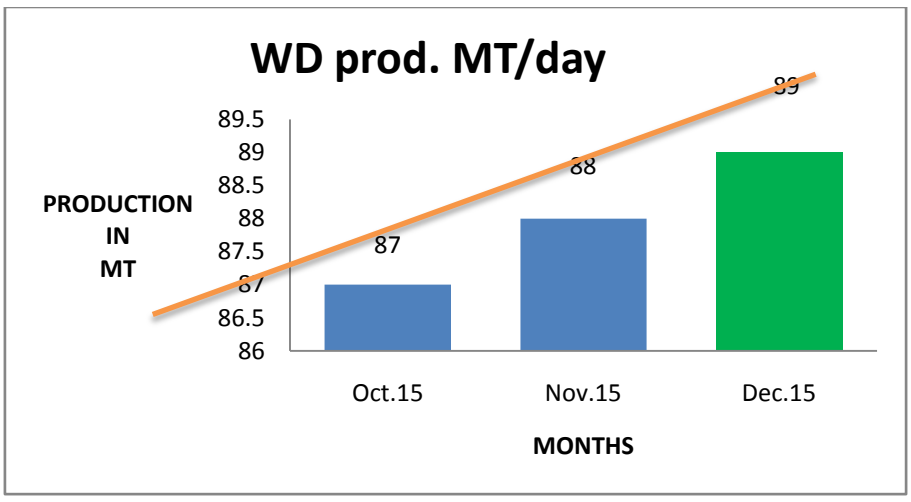

Fig. 6 *shows the production growth*

3. **Reduction in down time of machine:**Graph shown below represent the downtime trend analysis of wire drawing form month July- December.

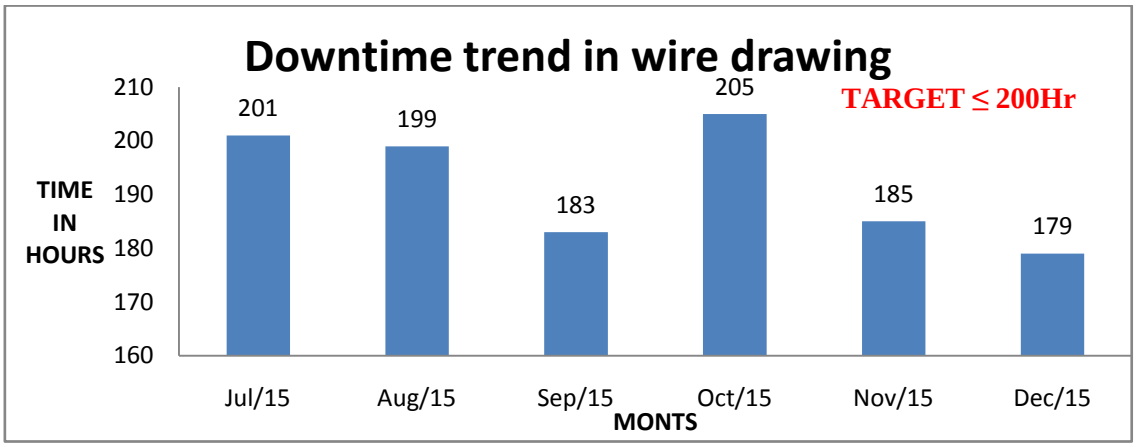

Fig. 7 shows downtime of wire drawing

Increase in the M/C efficiency

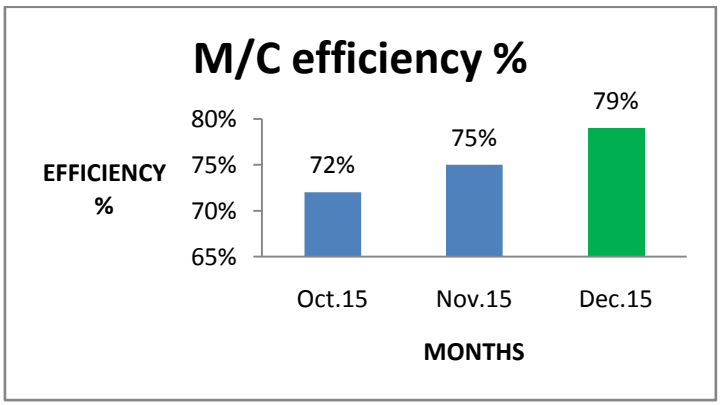

Fig. 8 shows the efficiency of m/c of wire drawing

MTBF of wire drawing

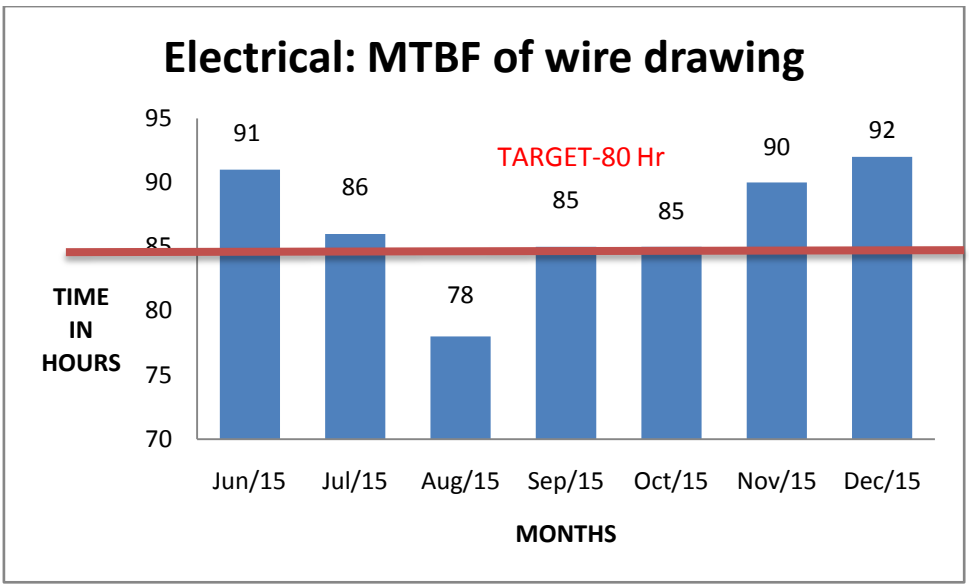

***Fig. 9** shows MTBF of wire drawing*

CONCLUSIONS

It is evident that to sustain in this competitive environment, every company/organization needs to be reduce in the idle or down time, increase working condition, better utilization of resources(man ,money, material, machine and methods), so as to enhance the productivity and production of the company. It helps to increase the customer satisfaction, which is very important for an organization. And for this root cause analysis (RCA) pay a vital role. The result shows that, if we are able to prevent failure of machine by providing training to the employees, it helps to increase predictive and preventive maintenance which will increase the efficiency of the system and ultimately enhance the productivity. Root cause analysis (RCA) helps to identify actual reason of the failure occurrence, so, it can be prevented for future and it will not happened again. Following are the salient findings of our research:

- Reduction in the number of RCA performed in the month of December, it shows that the long time failure is less after the implementation of new method.
- Increase in the production by 1MT in month of December from 88MT to 89 MT. This is very important to the company.
- Efficiency increases by 4% after the implementation of new method from 75 to 79.
- Reduction in the downtime of machine.

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